Kern River No. 1 Hydroelectric System,
Powerhouse Exciters
Kern River Canyon
Bakersfield Vicinity
Kern County
California

HAER No. CA-165-A

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

Historic American Engineering Record
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Location: The Kern River No. 1 powerhouse is located in Section 29, T. 28 S., R. 30 E. Mount Diablo meridian, at a narrow point in a bend of the Kern River Canyon (UTM Coordinates 11/384440/3925220). The powerhouse is about 20 miles east of Bakersfield on state Highway 178.

Date of Construction: 1902-1907, ca. 1930

Builder: General Electric Company

Present Owner: Southern California Edison Company
2244 Walnut Grove Avenue
Rosemead, CA 91770

Original Use: Exciters

Present Use: Exciters

Significance: The Kern River No. 1 powerhouse is equipped with two exciters (small electric generators) to provide direct field current to the four 5000 kv generators. The No. 1 exciter is original equipment driven by a water wheel; the No. 2 exciter was modified about 1930 to operate on an electric motor. Kern River No. 1 Hydroelectric Project significance lies in the key role it played in the development of the Southern California Edison Company into the pre-eminent twentieth Century Southern California Electric Utility. It is also significant as a nearly intact example of a state-of-the-art hydroelectric power facility from the early twentieth Century.

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I. DESCRIPTION

Fowler (1923:636) described the as-built Kern River No. 1 Powerhouse as follows:

> "The site for Kern River No. 1 power house is partly natural and partly blasted from the face of the hill. The long axis of the building...is at right angles to the general trend of the stream, and is parallel to the axis of the pressure main [penstock] which emerges from the tunnel in the center of the retaining wall to the right of the power house (Photo CA-165-A-1, SCE Drawing 522379-1).
>
> The building, which measures 168 by 70 feet outside and 164 long by 48 feet 3 inches inside, is of very heavy reinforced concrete, with steel roof frame covered with galvanized roofing. The entire generating, transforming, and switching equipment is [in] the one main building. The generator room is in part separated from the switching apparatus, wiring ducts, and line cells by a wall running the length of the building. The transformers are set in alcoves cut through the partition wall and facing out into the generator room.

The powerhouse building is virtually unchanged to the present. The switching equipment has been moved out of the powerhouse building to an outdoor switchyard adjacent to the powerhouse on the south side (SCE Drawing 522376, Photo CA-165-A-1). Fowler (ibid.) continues:

> The four [generator] units are arranged in a line on the discharge side of the powerhouse, with their shafts parallel to and 12 feet from the wall. The shafts are therefore parallel to the long axis of the building. The generators by their arrangement fall into two groups of two each of which is placed as close as possible to its own end of the building. In the space between the two groups and on a line with the machines are the exciters, each one beside its pair of generators (Photos CA-165-A-2 and CA-165-A-3); the door on the discharge side of the building is between the exciters (Photo CA-165-A-4)."

The generators were supplied by General Electric Company, and are their ATB 5,000-kilovolt-ampere 24 pole model,

> "...giving 1,260-ampere 2,300-volt 3-phase 50-cycle[1] alternating current at 250 revolutions per minute....By 1914 the generators were entirely enclosed and ventilation was provided by forced circulation of precooled air." (Fowler 1923:637)

Originally, the two exciter sets were identical in type and capacity. They were:

> "...General Electric 8-pole 225-kilowatt machines, designed to give 1,800 amperes at 125 volts with 430 revolutions per minute (Photos CA-165-A-5 and CA-165-A-6). The generator of each exciter set is mounted in the center of the unit, the [Allis-Chalmers] impulse wheel furnishing motive power is at one end and a large flywheel is at the other end of the main shaft (SCE Drawing C254 [originally M158342]). Each exciter also is furnished with a [Lombard] governor, which acts on a deflector turning down over the jet instead of deflecting the nozzle" (Fowler 1923:637) (Photos CA-165-A-7, CA-165-A-8, CA-165-A-10, and CA-165-A-11; SCE Drawing E433).

Of the original exciters, only exciter no. 1 remains in its original condition (Photos CA-165-A-7 and CA-165-A-8). Exciter no. 2 was modified about 1930 by removal of the impulse wheel and installation of a General Electric 240 horsepower alternating current electric motor as motive power (Photo CA-165-A-9; SCE Drawings K4956551 and A2701). The basic generator workings of both are original and identical (Photos CA-165-A-12 and CA-165-A-13).

The function of an exciter in the generation of alternating current electric power is to provide direct current for the generator rotor windings, or field windings. The exciter maintains generator voltage, controls kilovar flow, assists in maintaining power system stability, and provides important protective functions (Rustebakke 1983:80). The exciter directly affects generator unit reliability and availability by keeping the machine in synchronism with the rest of the electric power system.

II. HISTORICAL CONTEXT

The Kern River No. 1 Hydroelectric Project is significant as a well-preserved example of a state-of-the-art hydroelectric power plant from the first decade of the twentieth century. It also

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[1] In 1945 the entire Edison system was converted to 60-cycles for uniformity with adjacent utilities and to integrate portions of the Edison system that had operated at 60-cycles since early in the century (Myers 1983:202-203).

played a key role in the development of Southern California Edison Company into the pre-eminent electrical utility company in Southern California.

During the 1890s, many of the power generation and transmission technologies that would drive the power industry during the twentieth century were developed and demonstrated. The first electrical power generation and distribution systems in the United States utilize direct current technology. As conceived then, direct current posed severe limitations on transmission distance. This limitation was resolved by about 1890 by the development of alternating current generators. The step-up-step-down transmission process, an indispensable ingredient of long-distance power transmission, was first used in Southern California Edison's San Antonio Creek project in 1892, although at relatively low voltage. The use of three-phase generation, a major breakthrough in providing power in a manner useful to industrial operations, is attributed to Southern California Edison's Mill Creek No. 1 plant. Southern California Edison's 1898 Santa Ana River No. 1 plant was among the first to step up transmission to very high voltages for long distance transmission (83 miles to Los Angeles) (Myers 1983:26-42).

Other than its pioneering the use of all steel towers for long distance power transmission, Kern River No. 1 did not demonstrate the kinds of fundamentally new technologies associated with the San Antonio and Mill Creek projects. The Kern River No. 1 plant is important because it was the first Southern California plant to use these new technologies in a very large-scale (for the time) application. When complete and brought on line in 1907, Kern River No. 1 more than doubled the generation capacity of the Southern California Edison Company (Fowler 1923:536 and 539).

The Edison Electric Company (re-incorporated as Southern California Edison Company in 1910) emerged in 1902 from a series of amalgamations among numerous small power companies that operated in the Southern California area during the 1890s (Fowler 1923:532-538). These predecessor companies (and those acquired after 1902) were organized to serve small local markets. With the development of long-distance power transmission capability, the economic advantages of serving larger markets with large capacity base-load generation was recognized.

The West Side Lighting Company, incorporated in June 5, 1896, is considered the initial Edison Company component because, although not chronologically first, its owners finally obtained control of the system (Fowler 1923:532). The Edison name was obtained in 1897 when the Los Angeles Edison Electric Company nominally purchased and consolidated with

West Side Lighting[2]. By the 1902 re-incorporation as Edison Electric Company, the absorbed power companies included Pasadena Electric Light and Power Company, Santa Ana Gas & Electric Company, Mountain Power Company, Redlands Electric Light & Power Company (owners of the Mill Creek power plants), Southern California Power Company (who initiated construction on Santa Ana No. 1), Lytle Creek Light & Power Company, in addition to West Side Lighting and Los Angeles Edison Electric (op. cit.:533).

These acquisitions left Edison Electric with the larger market sought by its managers, but saddled with numerous small and obsolete steam plants and a few pioneer hydroelectric plants from which to serve its burgeoning demand for power. In 1902, Santa Ana River No. 1 at a capacity of 3,000 kilowatts (kw) was the largest plant on the system (Fowler 1923:536, Table 96).

Planning for Kern River No. 1 began in 1901 by California Power Company. This company was nominally organized in 1901 by the promoters of Redlands Electric Light & Power Company, but was from the outset under the control of the Edison Electric Company. The purpose of the California Power Company was to complete certain preliminary work on Kern River including acquire water rights filed during the year 1900. In 1902 the properties of the California Power Company were formally taken over by the Edison Electric Company, which undertook construction the project in its own name (Fowler 1923:535-536).

Between 1902 and 1907, the Edison Electric Company added 8,500 kilowatts (kw) of hydroelectric generation (Mill Creek No. 3, Lytle Creek, and Santa Ana River No. 2) to an existing hydro capacity of 4,250 kw, and 10,000 kw of steam generation to an existing total of 2,750.[3] Total Edison generation capacity was 19,425 kw in 1907 (Fowler 1923:536, Table 96, and 538-539). When Kern River No. 1 was brought on line, it increase this capacity to 39,425 kw (op. cit.:539). Kern River No. 1 remained the largest plant on the Edison system until completion of the 47,500 kw Long Beach Steam Plant in 1914 (Myers 1983:49). Kern River No. 1 was the largest capacity hydroelectric plant until the 1917 purchase/merger with

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[2] In 1894, a group of San Francisco financiers organized the Los Angeles Edison Electric Company in order to obtain a license from Thomas Edison's General Electric Company to use the Edison name and Edison patents in the Los Angeles area. This Company never owned or operated a power system. In the consolidation with West Side Lighting, West Side Lighting provided the physical plant and franchises, and Los Angeles Edison supplied the Edison name and equipment licenses. (Myers 1983:35-37)

[3] The total steam generation capacity in 1902 was 2,175. However, Los Angeles No. 1 steam plant with a capacity of 1,250 was retired in 1904 as Los Angeles No. 3 steam plant went on line. (Fowler 1923:536-539)

Henry E. Huntington's Pacific Power & Light Corporation, through which Edison acquired the massive Big Creek Project (Fowler 1923:563-587).

Survey of the Kern River for power plant sites, and design of Kern River No. 1 was undertaken by F. C. Finckle, Chief Engineer for California Power Company, and Edison Electric when the latter acquired California Power. Finckle identified five potential hydroelectric power sites along the Kern River. The site on the main flow of the Kern River lowest in elevation and nearest the mouth of the Kern River Canyon was to be Kern River No. 1. Kern River No. 2 was to be located on the main flow of the river upstream from Pacific Power & Light's Borel Power Plant (built 1904). Kern River No. 3 was located on the North Fork Kern River above Kernville. Kern River Nos. 4 and 5 were to be located on the North fork upstream from Plant No. 3. Only Kern River No. 1 and No. 3 were built (Mikesell 1989:8-5).

Finckle oversaw construction of Kern River No. 1, and unfortunately one of his design innovations was to prove his undoing. Finckle proposed construction of the pressure pipe or penstock by drilling a tunnel through rock and lining it with a thin coat of concrete. The pressure pipe failed and had to be reconstructed in 1909. Finckle resigned and was replaced as project engineer by William A. Blackenridge who designed and supervised construction of the new penstock. Blackenridge was subsequently hired as vice-president and General Manager of Edison in charge of engineering and construction (Mikesell 1989:8-5 and 8-6).

Kern River No. 1 required five years to construct mainly because of its (then) remote location. The nearest railroad was in Bakersfield and a spur line was built to Edison, a town which took its name from the siding station. From the railhead, material was brought by mule-drawn teams over a new road constructed for the project which traversed a mile of the precipitous Kern River Canyon gorge to the plant site. This road became State Highway 178. The route of the access road for the Project transmission line to Los Angeles was followed by the state and federal highway that would become known as the Grapevine (Interstate 5) (Myers 1983:44 and 46).

With few modifications Kern River No. 1 has served the electrical generation needs of the Edison Electric/Southern California Edison Company from 1907 up to the present. As the electrical demand and generation capacity of the Edison service territory grew, Kern River No. 1 (and for that matter, hydroelectric generation in general) has contributed an increasingly smaller portion of the Company's total generation mix. Because of its low capacity factor (by modern standards), high relative maintenance costs per kilowatt-hour generation, and comparatively burdensome regulatory operational environment, Kern River No. 1 and other hydroelectric plants of its era face difficult economic times.

III. SOURCES

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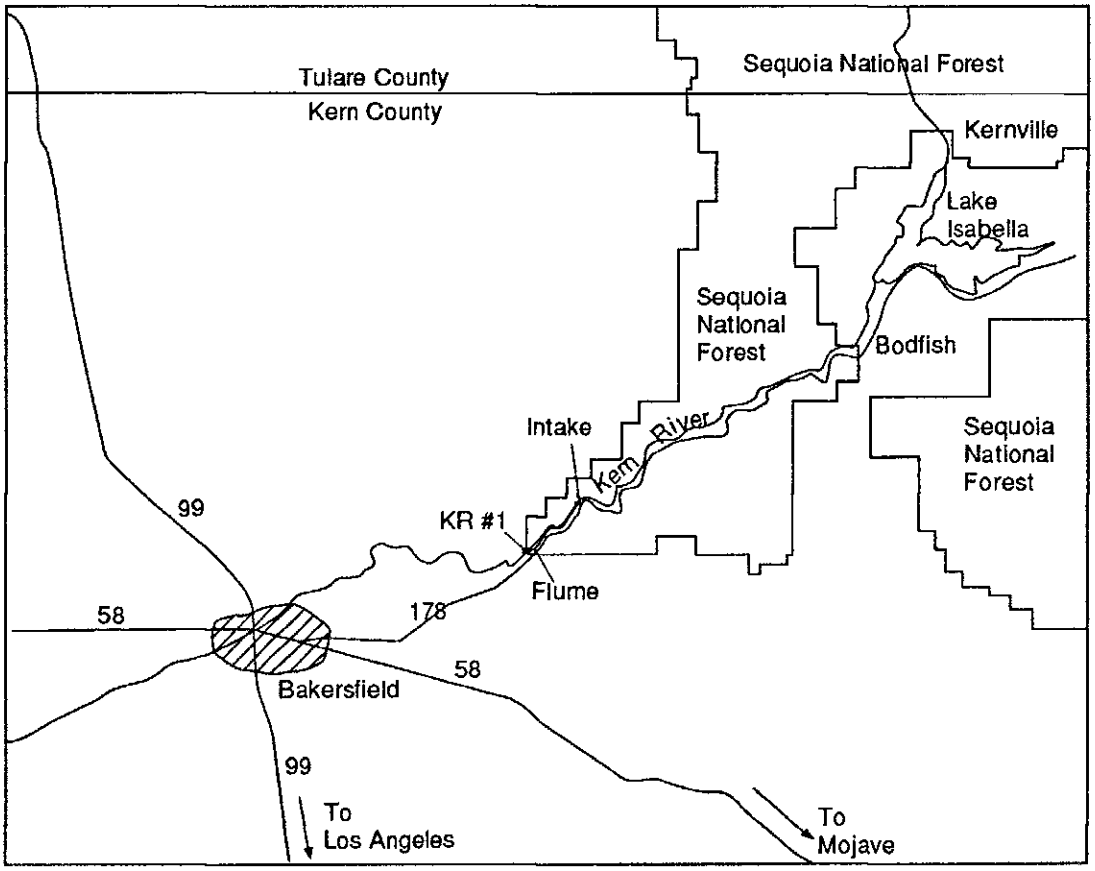
IV. PROJECT INFORMATION

This Historic American Engineering Record documentation of the Kern River No. 1 powerhouse exciters was undertaken because this equipment is obsolete and impedes the efficient synchronization of energy from Kern River No. 1 into the Southern California Edison electric grid. These mechanical exciters are being replaced with digital exciters mounted under the generator floor in the powerhouse building. The project entails removal of the old exciters and covering the floor where they are mounted.


Tulare County
Kern County
Sequoia National Forest
Kernville
Lake Isabella
Sequoia National Forest
Bodfish
Intake
Kern River
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Flume
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Bakersfield
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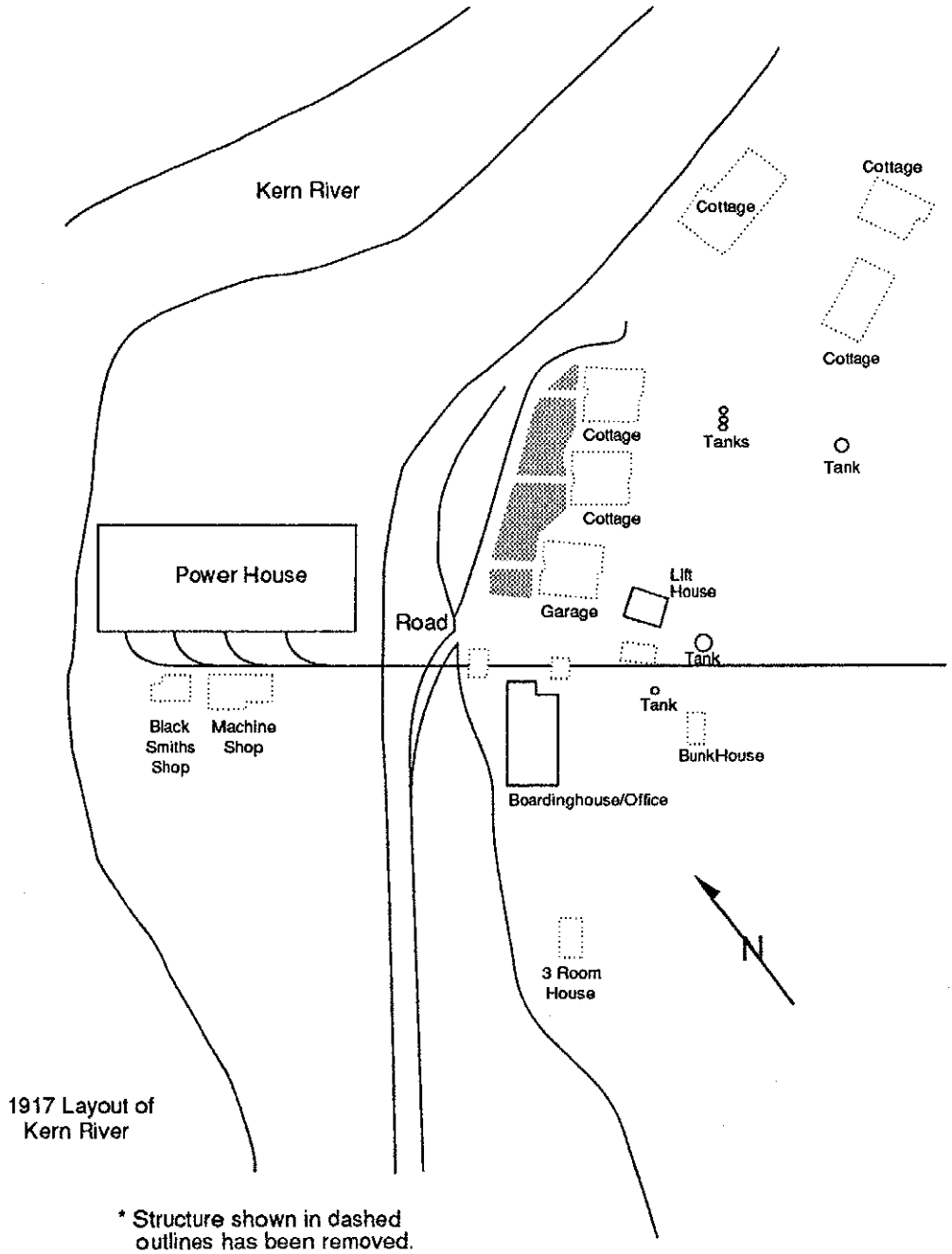
To Los Angeles
To Mojave



1917 Layout of Kern River

* Structure shown in dashed outlines has been removed.

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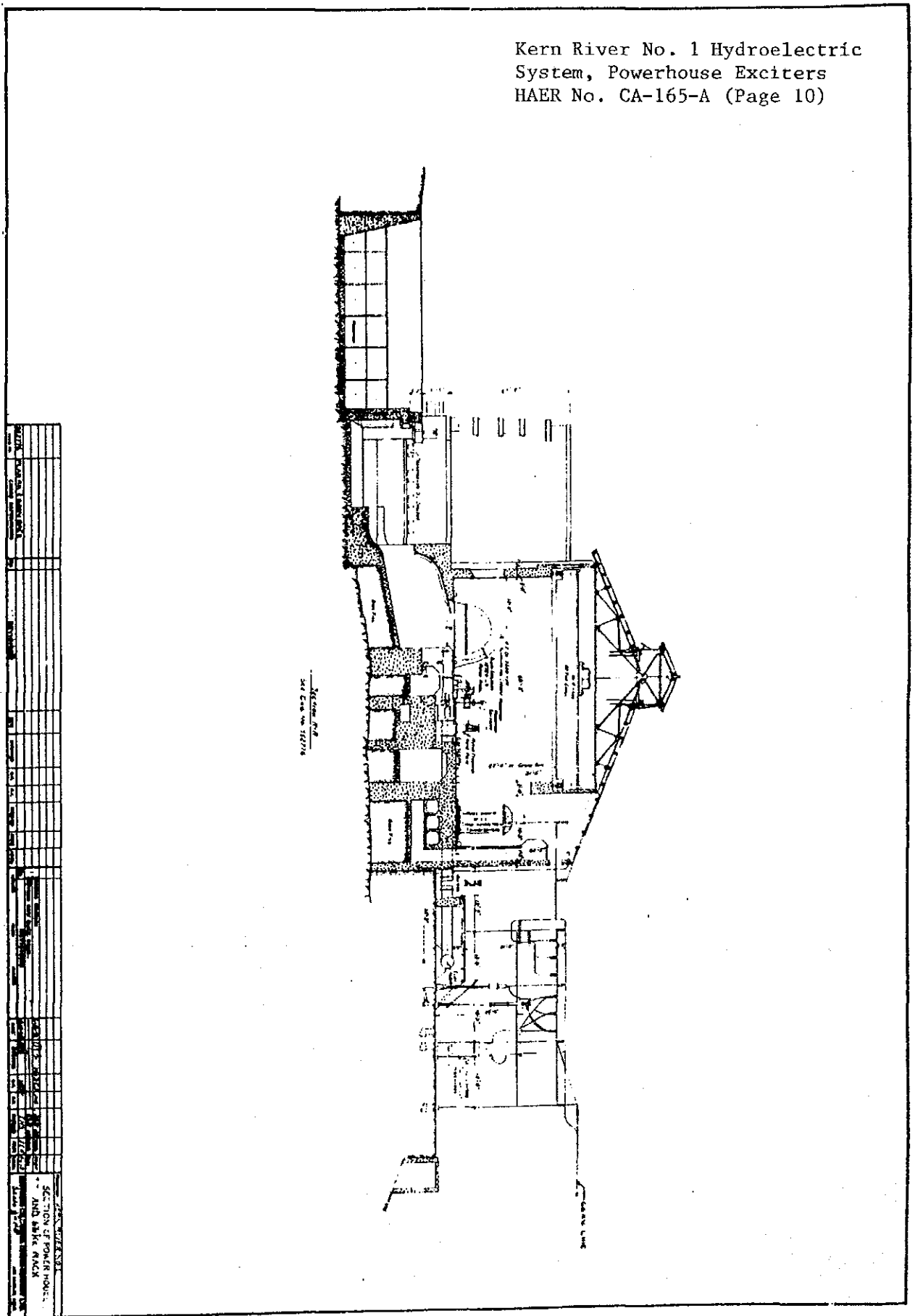

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